VIDEO WORKING GROUP

STANDARDS ARCHITECTURE

VERSION 0.97

26 March 1997

Preface

This document summarizes the Standards Architecture work to date by the National Imagery and Mapping Agency (NIMA) Video Working Group (VWG). VWG Points of Contact include:

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1.0 INTRODUCTION

1.1 Mission

Whereas, video imagery has been recognized by the Department of Defense / Intelligence Community (DoD/IC) as a fundamentally important source of imagery intelligence, and whereas, real-time battlefield awareness, using video sensors such as Unmanned Aerial Vehicles (UAVs) has been a key technological advancement driving DoD/IC interest in video systems; the **Video Working Group** was established in July 1995, under the umbrella of the Imagery Standards Management Committee (ISMC) to formulate baseline standards for video within the U.S. Government, consistent with the United States Imagery Geospatial and Information System (USIGS) 2000 architecture.

This document is a direct expression of the Video Working Group (VWG) mission, and summarizes VWG work to date and therein becomes the Standards Architecture, Version 0.97, as presented to the Video Working Group for adoption on 16 January 1997 and as revised on 26 March 1997.

This Architecture is comprised of COMMERCIAL STANDARDS, INTEROPERABILITY PROFILES AND RECOMMENDED PRACTICES FOR DOD/IC IMPLEMENTATIONS, and IMAGE QUALITY ASSURANCE RECOMMENDED PRACTICES. The differences of each type of specification are given in their respective document chapters.

1.2 General Applicability

The technology of the commercial video industry, portions of which DoD/IC users procure and use to meet government missions, is in a significant transition phase from analog to digital implementations. Over many years organizations such as the Society of Motion Picture and Television Engineers (SMPTE) have worked to standardize video systems to facilitate interoperability for the highest quality production and broadcast environments. Such standardization has supported the entire industry by giving broadcasters and production centers confidence that systems from multiple vendors would work interchangeably while also preserving the highest possible quality. The analog to digital migration has followed similar patterns, where standards have been in place for several years to facilitate interoperability of the highest quality digital production systems.

Standards and interoperability for low end (consumer grade) video systems (including Internet based video) are not as well defined, and for the special case of very low data rate dissemination of (at best) mediocre quality video, there are few if any standards. For such low bandwidth cases, universal interoperability is rightly a significant concern for DoD/IC managers.

Therefore, this Standards Architecture reflects the video industry technology upon which it is based. Over the past year the VWG has been able to identify commercial standards to define interoperability for high quality production environments, including high bandwidth transmission of compressed video signals.

This Standards Architecture has identified approaches for interoperability between the very high quality systems and low bandwidth systems but it does not, as of the production of this Version 0.97, completely define an architecture for very low bandwidth systems. It is anticipated that the VWG and the video industry as a whole will continue to research and refine the technologies required to improve very low bandwidth video systems.

Users of this Standards Architecture can look to this document for guidance on implementing very high quality production center based systems, such as common control vans, interconnections nodes, and DoD/IC command centers. All of the technology outlined in this document is commercially available. At its most basic technical level, users can consider the majority of this document as defining digital video for systems using data rates greater than 1.5 Mb/s (T1 and greater). Note that some portions of this Standards Architecture (such as STUDY 9720 and Appendix C) do provide preliminary guidance for sub-T1 data rates, however further standards research and coordination is required and will continue.

Note that by reference here (as of Version 0.97), video teleconference systems used for their intended purposes ("face to face" meetings between remote locations) are specifically excluded from this Architecture. When video teleconference systems are used as alternate video intelligence data dissemination systems then the requirements and provisions of this Standards Architecture apply.

1.3 Implementation Concepts

It is the intent of this document to give users a clear and concise view of the standards they will need to incorporate into their next generation video intelligence systems. There is however, a balance between simply noting a standard and noting the why and how such a standard should be used. To address this need for balance, this Standards Architecture (beginning with Version 0.97) will include Annexes which provide supplemental information users can refer to in order to better understand the underlying technical concepts of this document.

Appendix A provides supplementary information outlining the end-to-end engineering concepts underlying this document. This material is based primarily on existing VWG briefing documents: "General Introduction and Digital Video Architecture Concepts for DoD and Intelligence Applications" (3 Dec 1996); "Advanced Technology & Metadata Architecture Concepts for DoD and Intelligence Applications" (15 Jan 1997) and former section 5.0 (of Version 0.96) of this Standards Architecture. Appendix B provides information for the migration of legacy analog video systems to digital video systems. Appendix C provides information concerning very low data rate (sub T1) video dissemination systems. Note that there is a fair amount of chaos (from a standards perspective) in very low data rate video dissemination systems (such as QSIF Internet based video). Time is the only cure for such chaos and users must be flexible as this particular technology domain continually re-invents itself.

2.0 COMMERCIAL STANDARDS

Where the term STANDARD is used, this document assumes a binding technical implementation policy, based primarily on an identified commercial (or ITU) standard, and by formal adoption by the Video Working Group (VWG), as ratified by the Imagery Standards Management Committee (ISMC), becomes applicable to all Department of Defense/Intelligence Community (DoD/IC) video systems.

For point of clarification, in commercial practice the majority of identified standards (notably those from SMPTE) are considered to be "voluntary" standards, where equipment manufacturers and users are free to choose to comply or to not comply with the standard. Standards, as represented in this Architecture, chosen by specific VWG adoption (as ratified by the ISMC) are not considered voluntary for DoD/IC users and systems but form a binding technical implementation policy, and as such, may be identified in Government procurement actions as a mandatory requirement in order for vendor offerings to be considered compliant for acceptance by the Government.

This document acknowledges that Standards in and of themselves do not guarantee user interoperability. It may be useful to consider standards as providing "90% solutions." Users, user groups, and designated standards management groups (such as the NIMA Video Working Group) may then need to specify "profiles," "recommended practices," and/or "engineering guidelines" that adjust the basic standards to meet the last 10% of functionality and interoperability that broadly based commercial systems were never designed to meet. An example of the need for clearly defined recommended practices is the case where commercial standards (such as MPEG) may broadly define a capability that maximizes flexibility but does not guarantee interoperability. By carefully selecting "nominal" values from the ranges of choices within a standard, users can better shape interoperability for their classes of applications. It is also the case that in order for standards to achieve interoperability objectives, systems procured for DoD/IC missions must have certification authorities that warrant that the systems are compliant with applicable standards and that the systems do what the vendors claim they will do.

The Profiles, Recommended Practices and Studies of this document are included to expressly focus DoD/IC uses of commercial standards in order to better manage and support mission interoperability. Table 2.1 summarizes the Commercial Standards, Interoperability Profiles and Recommended Practices for DoD/IC Implementations, and Image Quality Assurance Recommended Practices forming the basis of this Architecture document. However, Table 2.1 shall not be used in lieu of the detailed descriptions of this document.

Table 2.1

Item	Formal Standard ID	Common Name	VWG Specification Extensions
9601 - Digital Video, Compression Systems		MPEG-2	
9701 - Digital Video, Compression Systems	ISO/IEC 13818-1,2,3,4	MPEG-2 4:2:2 P Profile @ ML	See detailed notes for specific extensions.
	ISO/IEC 13818-1,2,3,4	MPEG-2 4:2:0 MP @ ML	See detailed notes for specific extensions.
9702 - Digital Video Waveform	ITU-R BT.601-4	4:2:2 Component Digital Video	See detailed notes for specific extensions.
9703 - Digital Video, Uncompressed Baseband Signal Transport and Processing	SMPTE 259M - 1993	Serial Digital Interface (SDI)	See detailed notes for specific extensions.
9704 - Digital Video, Compression Conversions	SMPTE 259M - 1993	Serial Digital Interface (SDI)	See detailed notes for specific extensions.
9705 - Digital Video, Format Conversions	SMPTE 259M - 1993	Serial Digital Interface (SDI)	See detailed notes for specific extensions.
9706 - Video Image Still Frames	NITF 2.0	Video Still Specification	See detailed notes for specific extensions.
9707 - Digital Video Tape Recorder Input / Output Protocol	SMPTE 259M - 1993		See detailed notes for specific extensions.
9708 - Imbedded Time Reference	SMPTE 12M - 1995		See detailed notes for specific extensions.
9709 - Use of Closed Captioning for Core Metadata Analog Video Encoding	EIA-608 (Data Services)	Rec. Practice for Line 21	See detailed notes for specific extensions.
9710 - High Definition Television Systems (HDTV)	SMPTE 274M	High Definition Television	See detailed notes for specific extensions.
9711 - Intelligence Video Index, Geo-Spatial Metadata		Core Metadata Version 1.0, 14 Mar 97	See detailed notes for specific extensions.
Study 9712 - Intelligence Video Index, Content Description Metadata			See detailed notes for specific extensions.
Study 9713 - Advanced Video Index			See detailed notes for specific extensions.
9714 - Time Code Embedding			See detailed notes for specific extensions.
9715 - Time Reference Synchronization		Time Code synchronized to GPS	See detailed notes for specific extensions.
Study 9716 - Ancillary Data, Advanced Video Index Encoding			See detailed notes for specific extensions.
Study 9717 - Ancillary Data, Encoding into MPEG-2 Private Data Streams			See detailed notes for specific extensions.
Study 9718 - Ancillary Data, Encoding into AES3 Data Streams			See detailed notes for specific extensions.
Study 9719 - Analog Video Migration			See detailed notes for specific extensions.
9720 - Video Image Quality Specifications		VQ0 - VQ9	See detailed notes for specific extensions.
9721 - Video Tape Formats			See detailed notes for specific extensions.
9722 - Edit Decision Lists		Use of Edit Decision Lists	See detailed notes for specific extensions.
9723 - Advanced Television Systems (ATV)	ATSC Doc. A/53	US Advanced Television	See detailed notes for specific extensions.

9601 - Digital Video, Compression Systems

MPEG-2 is the approved video compression format for DoD/IC systems (the VWG and ISMC formally adopted this standard in 1996).

9701 - Digital Video, Compression Systems

The 1996 VWG adoption of MPEG-2 (item 9601 above) as the approved video compression format is hereby superseded by a more detailed specification:

ISO/IEC 13818 - 1,2,3,4 (commonly known as MPEG-2) shall be the DoD/IC STANDARD for all compressed video, with the following PROFILE specifications:

The "MPEG-2, 4:2:2 Production Profile @ Main Level" (4:2:2 P @ ML) shall be the DoD/IC compression PROFILE for initial link origination (see Note 2), transmission, production, manipulation, and computer based archiving (disk based).

The "MPEG-2, 4:2:0 Main Profile @ Main Level" (MP @ ML) shall be the minimum quality DoD/IC compression PROFILE for real-time and other end-user video product distribution, including wide area transmissions.

Notes:

1) "MPEG-2, 4:2:2 P @ ML" is the preferred format for origination and distribution where further image processing is anticipated, but "MPEG-2, 4:2:0 MP @ ML" shall be considered acceptable for wide area distribution applications such as GBS/JBS where limited additional processing is anticipated.

2) See Image Quality Assurance Recommended Practice 9720 for guidelines concerning applications constrained by low bandwidth channels and low video data rates, that may not support the use of 4:2:2 P @ ML or MPEG-2.

(VWG, 26 March 1997 - Approved as Amended)

9702 - Digital Video Waveform

ITU-R BT601-4 Component (4:2:2) Digital Video shall be the DoD/IC STANDARD for baseband (uncompressed) video signal waveforms.

Furthermore, while both 10 bit and 8 bit implementations are allowed under the standard, 10 bit implementations are preferred.

(VWG, 26 March 1997 - Approved as Amended)

9703 - Digital Video, Uncompressed Baseband Signal Transport and Processing

SMPTE 259M (Serial Digital Interface), using ITU -R BT601-4 Component (4:2:2) digital video waveforms, shall be the uncompressed baseband signal transport and processing DoD/IC STANDARD for digital video, audio and metadata origination, system interface, production/analysis center processing and manipulation.

Furthermore, all DoD/IC primary routing and distribution video hardware systems must comply with SMPTE 259M Levels C and D (270/360 Mb/s) implementations (270/360 Mb/s data rates allow routing and distribution systems to pass both 4:3 and 16:9 aspect ratio digital video signals).

Furthermore, one 259M AES3 audio channel (one stereo pair) shall be reserved for mission audio (such as narration), one 259M AES3 audio channel (one stereo pair) shall be reserved for mission metadata encoding.

Furthermore, at least 6 Mb/s of 259M ancillary data (separate from the AES3 requirements above) shall be reserved for metadata encoding.

Furthermore, 259M shall be the DoD/IC STANDARD protocol for compression system input signals and decompression system outputs when further processing is required.

Note:

The “Connector Type” specification given in SMPTE 259M, Section 4, recommends a preferred connector (BNC). For DoD/IC users, such physical connections can be considered to be a Recommended Practice, not a Standard.

(VWG, 26 March 1997 - Approved as Amended)

Note:

Further study is required to define the anticipated quality degradation of multiple “generation” (compression, decompression, compression,...) concatenation effects. See RP 9720 and Appendix A for initial guidance on how to best avoid concatenation degradation effects.

(VWG, 26 March - Approved for Study)

9704 - Digital Video, Compression Conversions

ITU-R BT601-4 shall be the transitional state, compression conversion and processing DoD/IC STANDARD for digital video, audio and metadata, where the input compressed video stream shall be uncompressed into ITU-R BT601-4 Component (4:2:2) baseband video (within 259M input/output signal processing equipment) and then shall be re-compressed into the target compression format.

Notes:

1) For guidelines on use of multiple compression conversion cycles see Image Quality Assurance Recommended Practice 9720.

2) The "Connector Type" specification given in SMPTE 259M, Section 4, recommends a preferred connector (BNC). For DoD/IC users, such physical connections can be considered to be a Recommended Practice, not a Standard.

(VWG, 26 March 1997 - Approved as Amended)

9705 - Digital Video, Format Conversions

ITU-R BT601-4 shall be the transitional state, format conversion and processing DoD/IC STANDARD for digital video, audio and metadata, where the input video format is converted into ITU-R BT601-4 Component (4:2:2) baseband video (within 259M input/output signal processing equipment) and is then re-formatted into target formats (such as 625 line component systems).

Notes:

1) The "Connector Type" specification given in SMPTE 259M, Section 4, recommends a preferred connector (BNC). For DoD/IC users, such physical connections can be considered to be a Recommended Practice, not a Standard.

2) This format conversion is intended to facilitate equipment interoperability between 525/60 (American) and 625/50 (NATO) video systems, where 259M has been designed for common digital video parameters wherever practical.

(VWG, 16 January 1997 - Approved as Amended)

9706 - Video Image Still Frames

The National Imagery Transmission Format (NITF 2.0 or higher) shall be the DoD/IC STANDARD for digital still images that have been extracted from video image sequences. Once an image has been captured for individual still image processing, exploitation and dissemination; the image is no longer considered to be video and is therefore not subject to this Video Working Group Standard Architecture (but must meet all NITF 2.0 or higher image standards).

Furthermore, still images should be extracted from full resolution 259M video streams, with direct conversion and storage into NITF image formats (using no transitional analog processing steps).

Furthermore, still images may be directly extracted from MPEG-2 digital files provided there are no transitional analog processing steps.

(VWG, 16 January 1997 - Approved as Amended)

9707 - Digital Video Tape Recorder Input / Output Protocol

SMPTE 259M (Serial Digital Interface) shall be the DoD/IC STANDARD protocol for digital video tape input/output signals.

Furthermore, IEEE 1394 input/output protocols may be considered for digital video tape systems provided transparent IEEE 1394 to 259M translation systems are commercially available and are demonstrated compatible with 259M systems.

Furthermore, “fibre channel” input/output protocols may be considered for digital video tape systems provided transparent “fibre channel” to 259M translation systems are commercially available and are demonstrated compatible with 259M systems.

Note:

The “Connector Type” specification given in SMPTE 259M, Section 4, recommends a preferred connector (BNC). For DoD/IC users, such physical connections can be considered to be a Recommended Practice, not a Standard.

(VWG, 26 March 1997 - Approved as Amended)

9708 - Imbedded Time Reference

SMPTE 12M, commonly known as SMPTE time code, shall be the DoD/IC STANDARD for time annotation and imbedded time references for video systems.

Furthermore, within 12M, Drop Frame Time Code shall be used for 29.97 FPS systems, Non-Drop Frame Time Code shall be used for 24, 25, 30, 50, 60 FPS systems.

Furthermore, the VWG will nominate for SMPTE adoption, a universal time code user bit identification value to specifically delineate a "real time acquisition" time code source from a derived (edited) time code source.

Note:

The commercial standards basis for 12M has a pre-planned amendment, scheduled by SMPTE for completion in 1997, which will include a standard implementation of Year (Y2K compliant), Month, and Date encoding in the Time Code User bits. Once adopted by SMPTE, DoD/IC users may anticipate that this amendment will become the DoD/IC STANDARD for year, month and date metadata time code encoding.

(VWG, 26 March 1997 - Approved as Amended)

9709 - Use of Closed Captioning for Core Metadata Analog Video Encoding

(This item has been moved to Appendix B as of 26 March 1997)

9710 - High Definition Television Systems (HDTV)

SMPTE 274M shall be the DoD/IC STANDARD for digital high definition video systems. Other HDTV digital standards may be adopted at future dates.

Note:

SMPTE 274M is one of the allowable formats of the Advanced Television System (see item 9723).

(VWG, 16 January 1997 - Approved)

9723 - Advanced Television Systems (ATV)

The "ATSC Digital Television Standard (16 Sep 95), Doc. A/53, shall be the DoD/IC STANDARD for Advanced Television Service (ATV).

Furthermore, whereas the Federal Communication Commission in its "Fourth Report and Order," (24 December 1996) adopted ATSC Doc. A/53 as the United States Digital Television Standard, except for Doc. A/53 Annex A, Section 5.1.2 (Compression format constraints) including Table 3; this NIMA Standards Architecture document specifically adopts the 18 scanning formats of Table 3 to be the DoD/IC STANDARD for ATV implementations.

Furthermore, DoD/IC ATV receiving systems must process all 18 formats of Table 3, and transmission systems must generate at least one of the 18 formats. The general parameters of Table 3 are repeated below:

Horizontal Pixels	Vertical Lines	Aspect Ratio		Picture Rate (I=interlace, P=progressive)			
1920	1080	16:9	_	60I	_	30P	24P
1280	720	16:9	_	_	60P	30P	24P
704	480	16:9	4:3	60I	60P	30P	24P
640	480	_	4:3	60I	60P	30P	24P

Note:

Table 3 does not include a 1920x1080 60 Hz Progressive Scan format. Once SMPTE or ITU standards (such as extensions to SMPTE 274M) are completed that address 1920x1080 60 Hz Progressive, such formats will be considered for future NIMA (Video Working Group) extensions to **9723 - Advanced Television Systems (ATV).**

(VWG, 26 March 1997 - Approved, replaces the language of Version 0.96 in its entirety)

3.0 INTEROPERABILITY PROFILES AND RECOMMENDED PRACTICES FOR DOD/IC IMPLEMENTATIONS

Where the term PROFILE is used this document assumes a documented extension to a STANDARD, promulgated by the VWG or standards organizations (such as SMPTE) in order to meet DoD/IC unique mission requirements not normally covered by commercial standards. Profiles chosen by specific VWG adoption (a VWG PROFILE, as ratified by the ISMC) should be considered as binding technical implementation policy, and as such, may be identified in Government procurement actions as a mandatory requirement in order for vendor offerings to be considered compliant for acceptance by the Government.

Where the term RECOMMENDED PRACTICE is used, this document assumes a recommended implementation or practice that further clarifies the implementation of a STANDARD in order to insure interoperability across DoD/IC systems. Recommended Practices chosen by specific VWG adoption (as ratified by the ISMC), should be considered to be a technical implementation policy, and as such, may be identified in Government procurement actions as a mandatory requirement in order for vendor offerings to be considered compliant for acceptance by the Government.

Where the term STUDY is used, this memo assumes a preliminary version of an anticipated STANDARD or PROFILE or RECOMMENDED PRACTICE where the primary initial parameters are outlined and understood but additional coordination or engineering analysis is required. Such items will be forwarded to the appropriate VWG sub-group or ad-hoc committees for action item work-off, with TBD completion suspense dates. At the time of recommendation for adoption, the STUDY will become a standard, profile, or recommended practice, using the same identification number.

9711 - Intelligence Video Index, Geospatial Metadata

The VWG Metadata Sub-Group Core Video Metadata Profile Version 1.0, 14 March 1997 is the DoD/IC RECOMMENDED PRACTICE for analog video intelligence Geospatial Metadata.

(VWG, 26 March 1997 - Approved)

Notes:

1) Version 1.0 was approved by the Imagery Standards Management Committee on 14 March 1997.

2) This Recommended Practice is nominated by the VWG for candidate harmonization with the Advanced Video Index Standard (which is currently under development by SMPTE Engineering Committee PT20.05) for digital video systems.

3) DoD/IC users may begin system development activities using this Core Geospatial Metadata, with the understanding that metadata parameters may change depending on negotiations and coordination with SMPTE and commercial video equipment manufacturers. The expectation is that the Geospatial metadata forms the initial core of the DoD/IC requirement set for the broader digital video Advanced Video Index Standard, and once part of the broader standard, will provide significantly enhanced applicability and broad, universal inter-operability with commercial index, archive, and Geospatial video systems. The new SMPTE standard should provide a single standard for both DoD/IC and commercial parties.

(VWG, 16 January 1997 - Approved for Study)

STUDY 9712 - Intelligence Video Index, Content Description Metadata

An ad-hoc sub-committee of VWG or the Video Archive and Dissemination Sub-Group will prepare a STUDY (eventual Recommended Practice) for the development of video intelligence content description Metadata.

Furthermore, once this STUDY is completed, it will be nominated by the VWG for candidate harmonization with the SMPTE Advanced Video Index Standard (which is currently under development by SMPTE Engineering Committee PT20.05).

The expectation is that the intelligence content description metadata will become a defined sub-set of the broader Advanced Video Index Standard, and once part of the broader standard, will provide significantly enhanced applicability and broad, universal inter-operability with commercial index, archive, and Geospatial video systems.

(VWG, 16 January 1997 - Approved for Study)

STUDY 9713 - Advanced Video Index

Once elements of STUDY 9711 and STUDY 9712 have been incorporated into the SMPTE Advanced Video Index Standard (which is currently under development by SMPTE Engineering Committee PT20.05), and have been evaluated by the VWG as meeting DoD/IC requirements, the SMPTE Advanced Video Index will become the DoD/IC STANDARD for video system metadata and will replace any systems incorporating RECOMMENDED PRACTICES 9711 and 9712.

(VWG, 16 January 1997 - Approved for Study)

STUDY 9714 - Time Code Embedding

Digital Vertical Interval Time Code (D-VITC) shall be imbedded on digital video line 9 of all ITU-R BT601-4 Component (4:2:2) and 259M systems. Users may implement Longitudinal Time Code (LTC) for internal processing (such as in tape recorders) provided D-VITC is always forwarded to the next processing element on digital video line 9.

Furthermore, SMPTE Ancillary Time Code (embedded in the 259M Ancillary data space) may be used instead of D-VITC, provided such time code data is part of other metadata delivered by the ancillary data stream.

(VWG, 26 March 1997 - Approved as Amended)

STUDY 9715 - Time Reference Synchronization

Global Positioning System, universal coordinated time (UTC, also known as "Zulu"), clock signals shall be used as the universal time reference for DoD/IC SMPTE 12M time code systems, allowing systems using time code to accurately depict the actual Zulu time of day of video acquisition / collection / operations.

Furthermore, when DoD/IC "original video acquisition" video sequences are used as sources for editing onto new "edit master" sequences, the "edit master" sequence may have a new, linearly contiguous time code track. The time code for the new sequence should reflect the "document date" of the new video product.

(VWG, 26 March 1997 - Approved for Study)

STUDY 9722 - Edit Decision Lists

(This item has been deleted as of 26 March 1997. Edit Decision List issues will be incorporated into Metadata study efforts.)

STUDY 9716 - Ancillary Data, Advanced Video Index Encoding

Once elements of STUDY 9713 (the SMPTE Advanced Video Index Standard) have been adopted, a new "259M Ancillary Data Encoding Standard" (which is currently under development by a SMPTE Engineering Committee) will be created to define how STUDY 9713 can be encoded into the 259M Ancillary format.

Furthermore, once SMPTE adopts this standard and it has been evaluated by the VWG as meeting DoD/IC requirements, the SMPTE Ancillary Data, Advanced Video Index Encoding Standard will become a DoD/IC STANDARD for all video systems.

(VWG, 26 March 1997 - Approved for Study)

STUDY 9717 - Ancillary Data, Encoding into MPEG-2 Private Data Streams

Once elements of STUDY 9716 have been adopted, a new "Ancillary Data Encoding into MPEG-2 Private Data Streams Standard" (which will be shortly proposed for development by a SMPTE Engineering Committee) will be created to define how STUDY 9716 Ancillary Data will be encoded into MPEG-2 Private Data Streams.

Furthermore, once SMPTE adopts this standard and it has been evaluated by the VWG as meeting DoD/IC requirements, the SMPTE Ancillary Data Encoding into MPEG-2 Private Data Streams Standard will become a DoD/IC STANDARD for all video systems.

(VWG, 26 March 1997 - Approved for Study)

STUDY 9718 - Ancillary Data, Encoding into AES3 Data Streams

Once elements of STUDY 9716 have been adopted, a new "Ancillary Data Encoding into AES3 Data Streams Standard" (which will be shortly proposed for development by a SMPTE Engineering Committee) will be created to define how STUDY 9716 Ancillary Data will be encoded into AES3 Data Streams.

Furthermore, once SMPTE adopts this standard and it has been evaluated by the VWG as meeting DoD/IC requirements, the SMPTE Ancillary Data Encoding into AES3 Data Streams Standard will become a DoD/IC STANDARD for all video systems.

Furthermore, given that there is an existing SMPTE Standard for AES3 attachment to MPEG-2 Private Data Streams, it is anticipated that formatting metadata into AES3 will thereby allow use of an existing SMPTE standard to handle AES3 MPEG-2 Private Data Stream data encoding.

(VWG, 26 March 1997 - Approved for Study)

4.0 IMAGE QUALITY ASSURANCE RECOMMENDED PRACTICES

STUDY 9719 - Analog Video Migration

(This item has been moved to Appendix B as of 26 March 1997)

STUDY 9720 - Video Image Quality Specifications

A "Video Quality (Spatial and Temporal) Matrix" table shall define Video Image Quality specifications as a common shorthand reference for all DoD/IC video systems to facilitate descriptions of quality and mission satisfaction criteria. The "Video Quality Matrix" includes tables of Technical Specifications and Notes.

Furthermore, the quality specifications (VQ0 - VQ9, where VQ9 is the highest quality) should only be applied to any single processing node of the end-to-end video chain, with the overall system quality specification equaling, at best case, the poorest video quality processing node specification.

Furthermore, DoD/IC oversight organizations will need to determine methodologies to rate the end-to-end video chain quality specification and may use the same VQ scale to describe overall system performance. The VWG anticipates near-term development of commercial test equipment that will facilitate ratings of end-to-end video chain performance.

(VWG, 26 March 1997 - Approved as Amended for Study)

Video Quality (Spatial and Temporal) Matrix, Table of Technical Specifications

Quality Level	Intended Application	Common Description	Applicable Standard (Note: Other Profiles, Practices may apply)	Nominal Horiz. Res.	Nominal Vert. Res.	Nominal Bit Depth	Frame Rate	Target Compression Ratio	Target Data Rate	Data Rate Range	Candidate Transport Channels (Target Rate)
VQ9	HDTV Acquisition	HDTV	274M	1920	1080	10	60	Uncompressed	1.485 Gb/s	594 Mb/s - 1485 Mb/s	------
VQ8	HDTV Processing / Distribution	HDTV Over 259M Transport	Non-Standard (VWG Profile)	1920	1080	8 or 10	30/60	Uncompressed to 2:1	360 Mb/s	270 Mb/s - 360 Mb/s	0.5 OC-12
VQ7	ATSC Processing / Distribution	Advanced Television	ATSC Doc. A/53	1280-1920	720-1080	8 or 10	24 - 60	60:1	19.4 Mb/s	19.4 Mb/s - 38.8 Mb/s	8VSB, Partial T3
VQ6	Acquisition, Processing, Archive	Professional 601 Digital Video	259M (4:2:2) 4:3, 16:9* Aspect Ratios	720/960*	483	10	30 FPS	Uncompressed to 2:1 (see VQ6 Technical Notes)	270 Mb/s	270 Mb/s - 360 Mb/s	259M Cable, #T3@45Mb/s, #E4 @ 34Mb/s
VQ5	Acquisition, Processing, Archive	Professional Quality MPEG-2	MPEG-2 4:2:2 @ ML	704	480	8 or 10	30 FPS	5:1	44 Mb/s	30 Mb/s- 50 Mb/s	T3 , ATM
VQ4	Acquisition, Distribution	Industrial Quality MPEG-2	MPEG-2 4:2:2 @ ML	704	480	8	30 FPS	10:1	22 Mb/s	15 Mb/s - 30 Mb/s	T3/2, ATM
VQ3	Distribution	Consumer Quality MPEG-2	MPEG-2 4:2:0 MP @ ML	704	480	8	30 FPS	28:1	6 Mb/s	3.8 Mb/s - 10 Mb/s	GBS, DS2, ATM, DVD
VQ2	Distribution	SIF (CD-ROM Video Quality)	MPEG-1	352	240	8	30 FPS	28:1	1.5 Mb/s	1.0 Mb/s - 1.5 Mb/s	T1
VQ1	Distribution	QSIF (Internet Video Quality)	Non-Standard (VWG Profile)	176	120	8	15 FPS	28:1	512 Kb/s	256 Kb/s - 768 Kb/s	0.5 T1
VQ0	Distribution	Low Frame Rate Motion Imagery	Non-Standard (VWG Profile)	704/720	480/483	8 or 10	Still - 2 FPS	13:1	256 Kb/s	56 Kb/s - 512 Kb/s	X2 POTS, ISDN
											#=Non Real Time

Video Quality (Spatial and Temporal) Matrix, Table of Technical Notes

VQ9 Uncompressed digital high definition television systems (HDTV). VQ9 includes by specific reference the SMPTE 274M 1920x1080 HDTV format. Other HDTV digital standards may be incorporated into VQ9 at future dates.

VQ8 Compressed HDTV video. Note that while both 10 bit and 8 bit implementations are allowed under VQ8, 10 bit implementations are preferred. VQ8 is intended to describe HDTV signals that use soft compression to transport signals over SMPTE 259M distribution and processing systems. Therefore, all VQ8 primary routing and distribution hardware systems must comply with the SMPTE 259M Level D (360 Mb/s) implementations.

VQ7 Compressed ATV formats specified by Architecture STANDARD 9723 (not including 704/640x480). Note that while both 10 bit and 8 bit implementations are allowed under VQ7, 10 bit implementations are preferred. STANDARD 9723 704/640 x 480 formats are specifically noted as meeting only VQ4.

VQ6 Digital 4:2:2 baseband uncompressed video (ITU-R BT601-4 Component). Note that while both 10 bit and 8 bit implementations are allowed under VQ6, 10 bit implementations are preferred. Note that storage systems (such as some digital video tape formats) that use 259M 4:2:2 input/output protocols but use 2:1 (near lossless) internal compression will be considered as meeting VQ6. Furthermore, all primary routing and distribution hardware systems must comply with the SMPTE 259M Level C and D (270/360 Mb/s) implementations to meet VQ6. Users are cautioned that true uncompressed processing may be required for the most demanding VQ6 applications.

VQ5 Digital 4:2:2, MPEG-2 compressed video, with no more than 5:1 compression. Note that 5:1 compression ratio compliant MPEG-2, 4:2:2 Production Profile @ Main Level based systems are anticipated to meet VQ5.

VQ4 Digital 4:2:2, MPEG-2 compressed video, with no more than 10:1 compression. Note that 10:1 compression ratio compliant MPEG-2 4:2:2, Production Profile @ Main Level based systems are anticipated to meet VQ4.

VQ3 Digital 4:2:0, MPEG-2 compressed video, with no more than 28:1 compression. Note that MPEG-2 MP@ML based systems are anticipated to meet VQ3.

VQ2 Digital MPEG-2 (4:2:0) or MPEG-1 compressed video, using SIF image resolution decimation, 30FPS temporal rate, with no more than 28:1 compression.

VQ1 Digital compressed video (non-standard, but having the general attributes of MPEG-2 4:2:0), using a combination of image resolution decimation (as low as QSIF) and temporal (frame rate) decimation (on the order of 15 FPS). VQ1 is intended as a "end-user video distribution format of last resort," where severe bandwidth limitations preclude full resolution (spatial and temporal) motion video distribution. Furthermore other very low data rate, proprietary "Internet video" signal formats (such as AVI and Quicktime) are specifically defined as only meeting VQ1 specifications.

VQ0 Low frame rate motion imagery based on digital video sources using full VQ6 (ITU-R BT 601) spatial resolution but having very limited temporal resolution (on the order of stills to 1 or 2 FPS). At these low temporal rates, the imagery is no longer considered to be video (thus the motion imagery nomenclature). VQ0 is intended to describe applications where the most severe bandwidth limitations preclude delivery of true video. For these very low bandwidth applications, systems should deliver full spatial resolution but may need to severely decimate temporal elements to the point of producing only still frames (and delivering such frames in non-real-time based on the data rate capacity of the delivery channel). For the specific cases of still imagery derived from video sources, such imagery shall conform to NITF standards (see PROFILE 9706 - Video Image Still Frames).

STUDY 9721 - Video Tape Formats

In reference to STUDY 9720, "Video Quality (Spatial and Temporal) Matrix," the Image Quality Assurance Practices for DoD/IC video tape formats shall be as follows:

Tape Video Quality 9-7

There are no specific recommendations for Video Quality 9-7 video tape implementations as of Standards Architecture Version 0.97. However, any digital tape format converted into a "bit-bucket" mode with sufficient data bandwidth to store VQ9-7 signals may be used provided they also:

a) Transparently transport a minimum of two stereo AES3 audio channels,
b) Transparently transport Digital Vertical Interval Time Code (LTC internal processing/storage is authorized provided DVITC input and output is maintained),
c) Transparently transport a minimum of an additional 6 Mb/s of Ancillary data (either as part of the 259M Ancillary data stream or as additional AES3 audio streams).

Tape Video Quality 6

For Video Quality 6 implementations authorized video tape formats may include widely accepted commercial systems that:

a) Use 4:2:2 digital processing,
b) Use no compression or use no more than 2:1 compression,
c) Use 259M (SDI) input/output protocols,
d) Transparently transport a minimum of two stereo AES3 audio channels,
e) Transparently transport Digital Vertical Interval Time Code (LTC internal processing/storage is authorized provided DVITC input and output is maintained),
f) Transparently transport a minimum of an additional 6 Mb/s of Ancillary data (either as part of the 259M Ancillary data stream or as additional AES3 audio streams).

Anticipated VQ6 compliant (subject to verification) tape formats may include :

SMPTE D1 video tape format
SMPTE D5 video tape format
Ampex DCT video tape format
Sony Digital Betacam tape format

Tape Video Quality 5

For Video Quality 5 implementations, authorized video tape formats may include widely accepted commercial systems that:

a) Use 4:2:2 digital processing,
b) Have no more than 5:1 compression,
c) Use 259M (SDI) input/output protocols,
d) Transparently transport a minimum of two stereo AES3 audio channels,
e) Transparently transport Digital Vertical Interval Time Code (LTC internal processing is authorized provided DVITC input and output is maintained),
f) Transparently transport a minimum of an additional 3 Mb/s of Ancillary data (either as part of the 259M data stream or as additional AES3 audio streams).

Anticipated VQ5 compliant (subject to verification) tape formats may include :

Any VQ6 video tape format
SMPTE D9 (JVC Digital-S) video tape form at
Sony Beta-SX video tape format
SMPTE D7 (DVC Pro 4:2:2) video tape format

Video Quality 4 through Video Quality 0

For all other Video Quality implementations (VQ4-0), it is anticipated that computer based storage systems will be used instead of video tape . If video tape is used, digital video tape formats other than VQ5 (or higher) may only be used in order to meet specific mission constraints (size, weight, power consumption) that can not be met with VQ5 (or higher) tape formats. In such instances, other such formats may only be used in limited roles such as first generation acquisition, with a requirement to immediately transfer and interface such acquisition formats to SMPTE 259M (with VQ5 or higher tape systems) at the first processing interface.

Anticipated "acquisition-only" tape formats, in order of priority of choice are:

a) Any VQ6 video tape format
b) Any VQ5 video tape format
b) 4:1:1 Digital tape formats
c) Component Analog formats (Y,R-Y,B-Y), such as Betacam-SP or MII
d) High Resolution Analog formats (Y/C), such as Hi8mm or SVHS

Other Video Tape Notes:

"Analog - composite - limited resolution - color under" video tape formats (such as VHS or U-Matic) are not authorized for acquisition, processing or new archive implementations. "Analog - composite - limited resolution - color under" video tape formats may be authorized as the means for video tape mass distribution of finished intelligence products, provided no other digital distribution tape format is widely available. In no case are such formats authorized for new permanent video archive storage. Existing, legacy archive systems based on "analog - composite - limited resolution - color under" tape formats should convert to one of the new, approved digital tape formats as soon as practical.

Digital composite formats (such as D2, D3) are generally not authorized for any new DoD/IC implementations because of their incompatibility with 4:2:2 component processing systems.

No video tape formats other than VQ5 or higher may be u sed for any new permanent video tape archives, where VQ6 systems should be used for the most demanding applications.

(VWG, 26 March 1997 - Approved for Study)

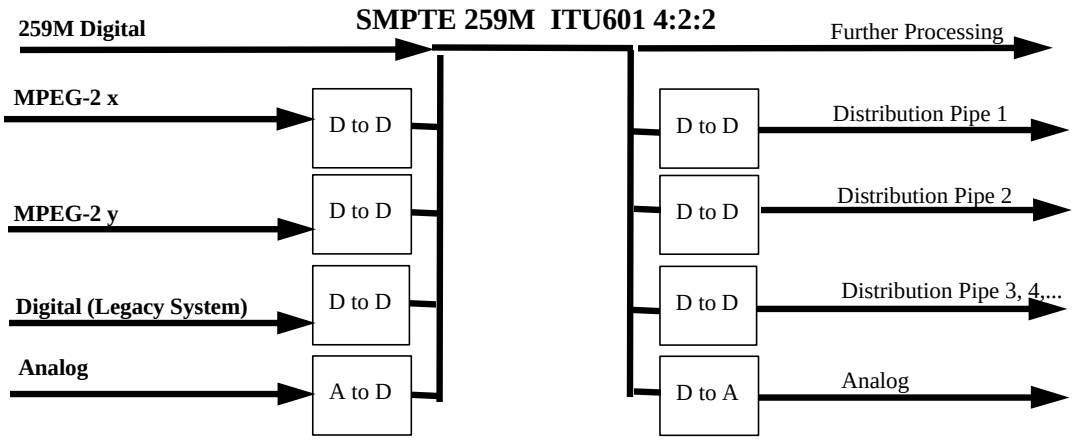
APPENDIX A

Note: This Section is a Work In Progress.

Appendix A provides supplementary information outlining the engineering concepts underlying this document. This material is based primarily on existing VWG briefing documents: "General Introduction and Digital Video Architecture Concepts for DoD and Intelligence Applications" (3 Dec 1996); "Advanced Technology & Metadata Architecture Concepts for DoD and Intelligence Applications" (15 Jan 1997) and former section 5.0 (of Version 0.96) of this Standards Architecture.

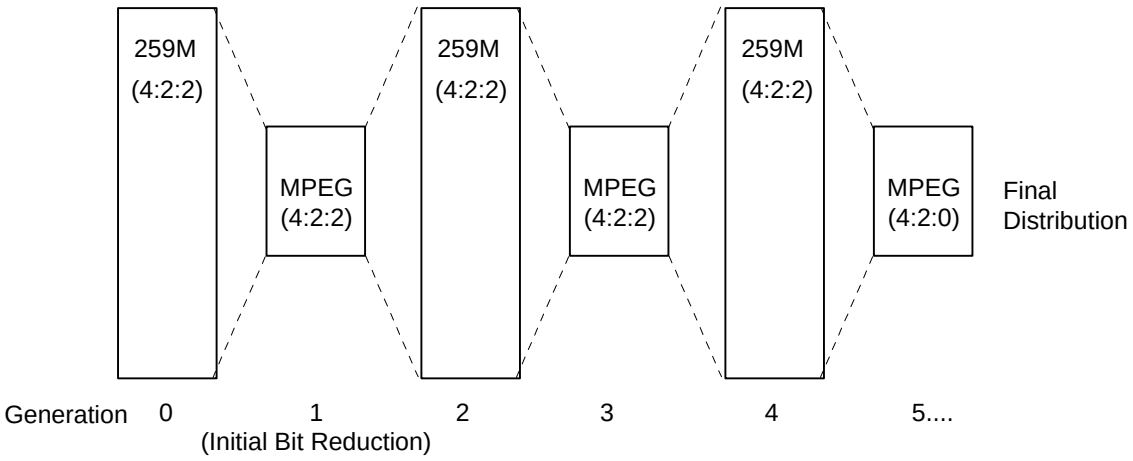
Figures in this section illustrate typical implementations of the standards and practices of this architecture. However, no references from these figures shall be used in lieu of the detailed descriptions of Sections 2, 3 and 4 of this document.

259M As the Universal Interoperable Video Exchange Format

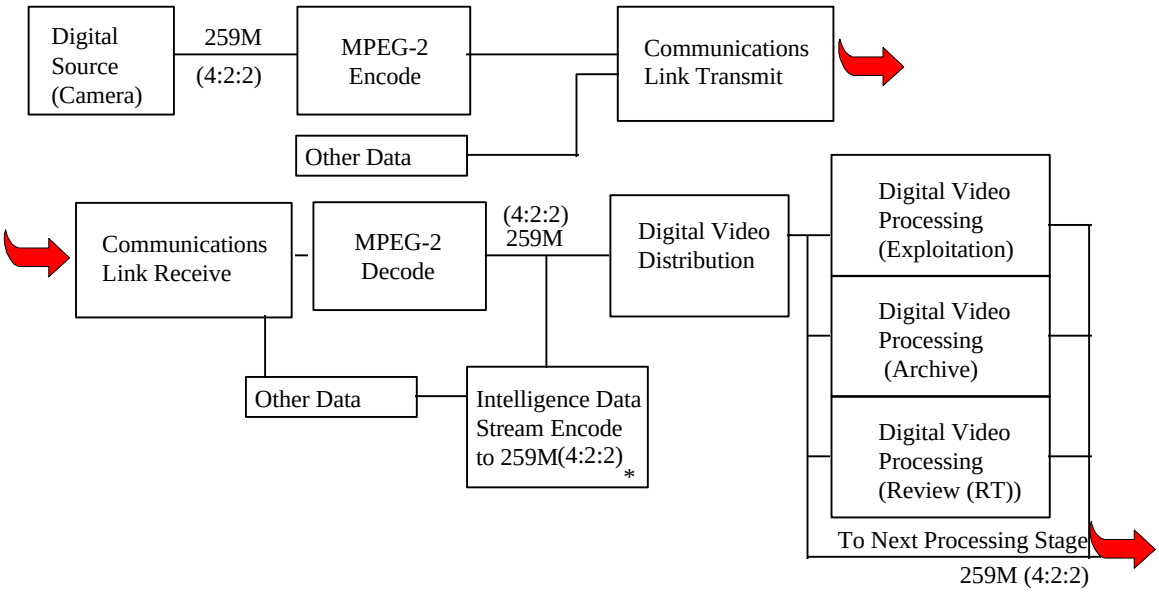


259M also used as 525 line / 625 line transcode digital interface (still requires transcoders but easier than analog).

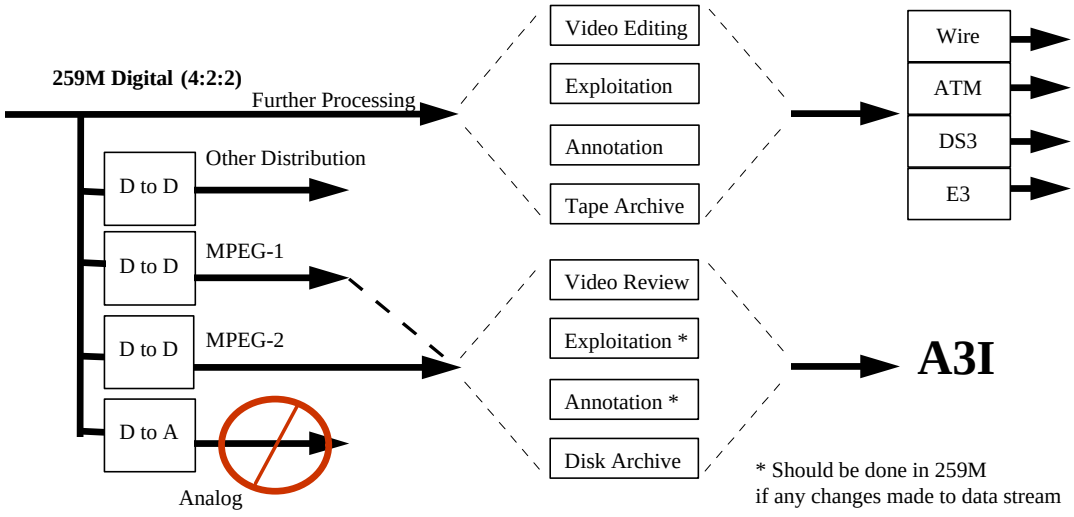
259M / MPEG-2 Provides Robust Video Generation Protection



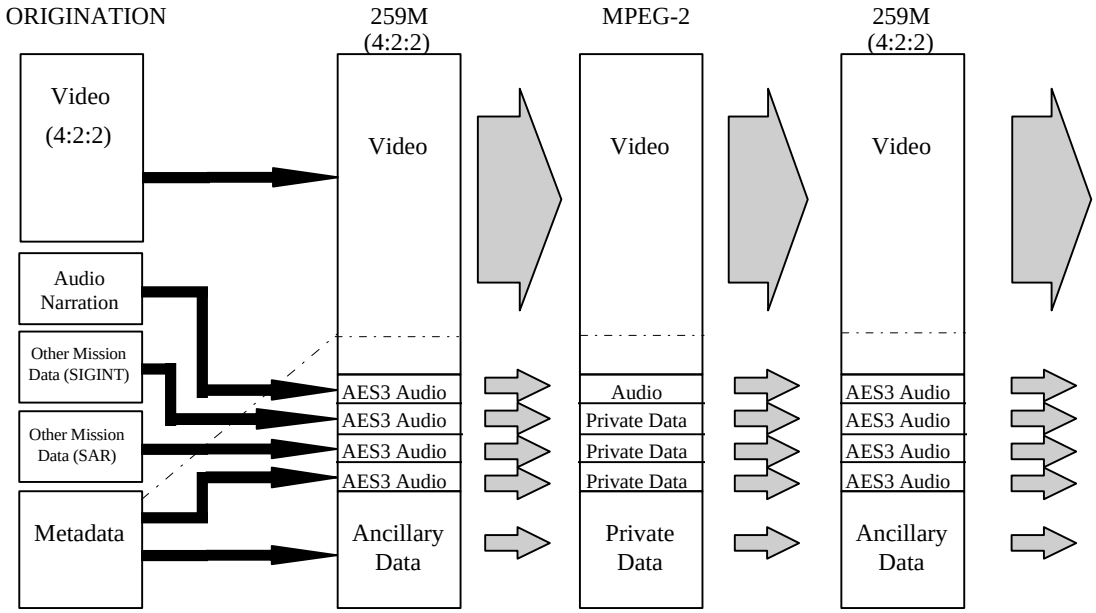
End to End Digital Video Operations Concept



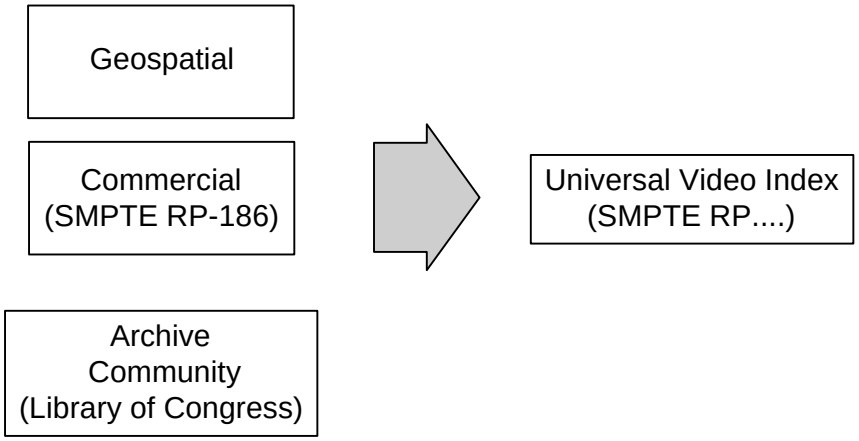
End to End Digital Video Operations Concept



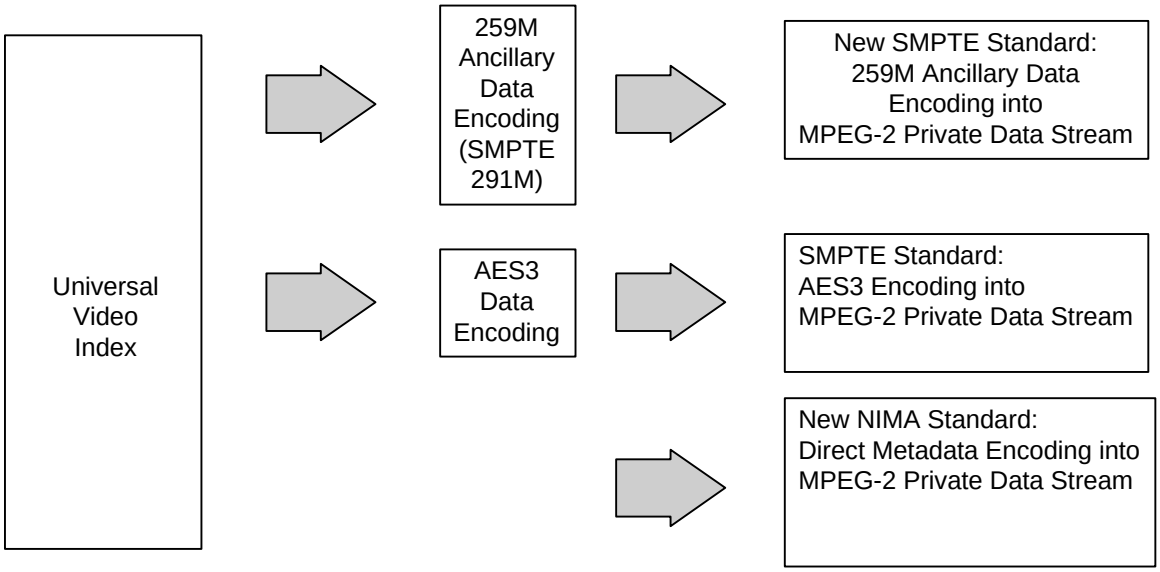
Solving The Video Metadata Problem: Use 259M / MPEG-2 for Video / Data Interchange



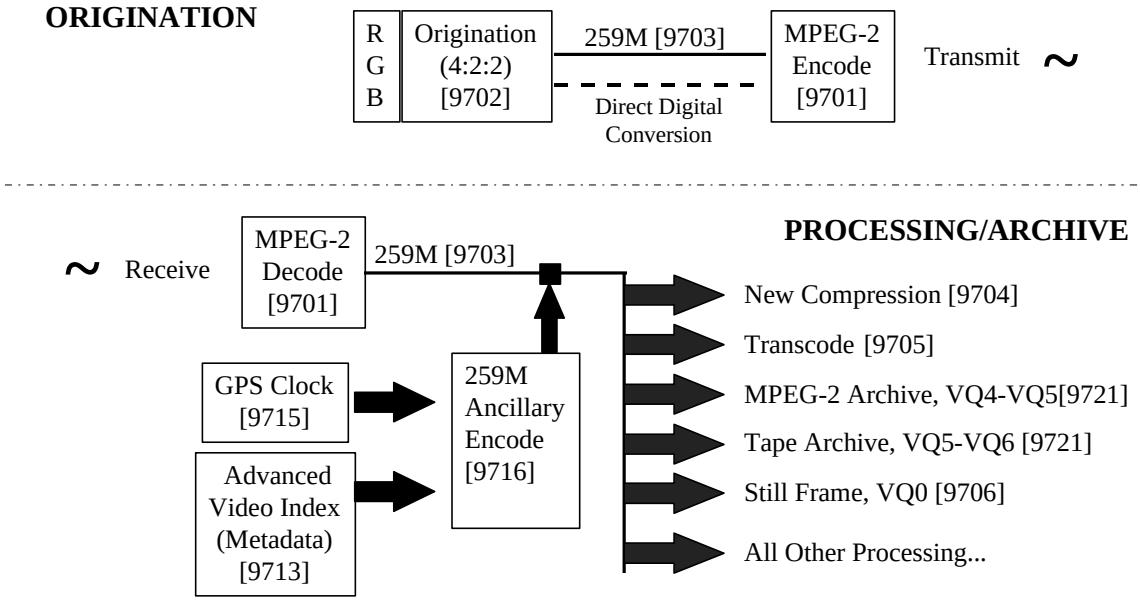
Solving The Video Metadata Problem: VWG Vision - Universal Video Index System



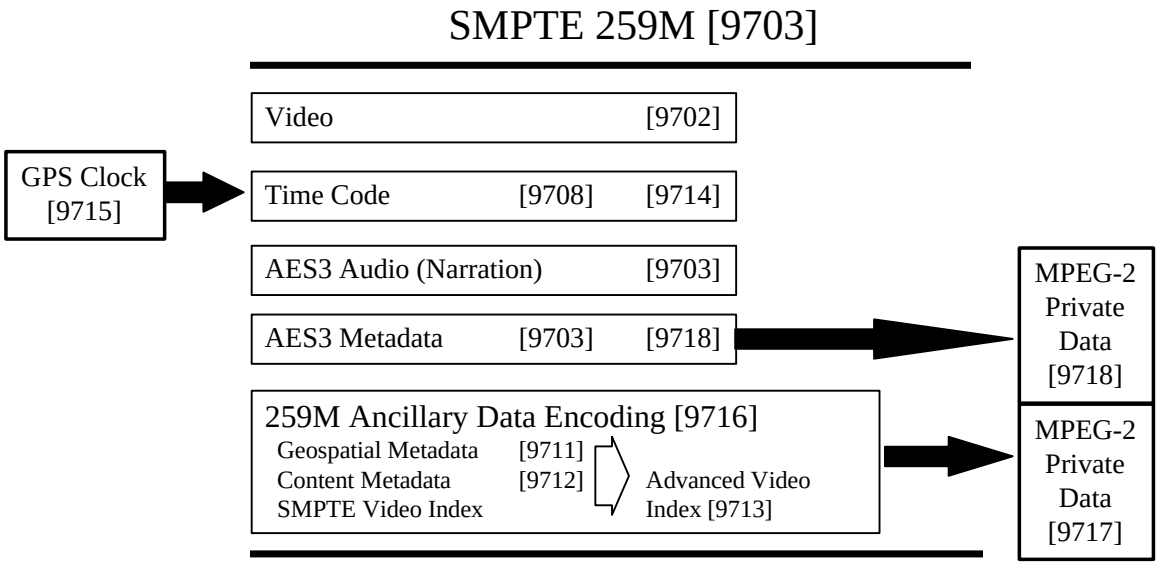
Solving The Video Metadata Problem: VWG Vision - Universal Metadata Imbedding



Solving The Video Metadata Problem: VWG "Standards Architecture" Concepts



Solving The Video Metadata Problem: VWG "Standards Architecture" Concepts (Cont.)



APPENDIX B

Note: This Section is a Work In Progress.

Appendix B provides information for the migration of legacy analog video systems to digital video systems.

Analog Video

Reference STANDARD 9709 - Use of Closed Captioning for Core Metadata Analog Video Encoding

EIA-608 (Data Services), commonly known as closed captioning, shall be the DoD/IC STANDARD for legacy system analog video vertical interval metadata encoding using video line 21.

Note that any such analog video system data encoding is to be considered for legacy analog systems and may also be implemented by new systems for redundancy. New systems shall also conform to all applicable digital video, audio, and metadata protocols specified in this Architecture document.

Architecture item 9711 shall be the basis for Geospatial metadata descriptions for DoD/IC systems using Closed Captioning (until replaced by Architecture item 9713).

Architecture item 9714 shall be the basis for time references for analog video vertical interval data. Therefore, Architecture item 9709 implementations should not be burdened with duplicate time reference data.

Furthermore, to facilitate universal inter-operability, DoD/IC users are encouraged to submit recommended implementations for analog closed captioning systems for consideration and inclusion in this Architecture document by the VWG as numbered Recommended Practices.

(VWG, 16 January 1997 - Approved as Amended)

Reference STUDY 9714 - Time Code Embedding

Legacy DoD/IC analog video systems that require Time Code shall imbed Time Code on analog vertical interval video line 19. Users may implement Longitudinal Time Code (LTC) for internal processing (such as in tape recorders) provided analog video line 19 VITC is always forwarded to the next processing element.

(VWG, 26 March 1997 - Approved for Study)

Reference STUDY 9719 - Analog Video Migration

All DoD/IC video production systems that currently use ANSI/SMPTE 170M analog video waveforms (also known as RS-170A) should convert to ITU-R BT601-4 Component (4:2:2) digital waveforms as soon as practical.

Furthermore, all new digital baseband video system production waveforms shall conform to ITU-R BT601-4 Component (4:2:2) waveforms.

Furthermore, unique mission systems with legacy analog video waveforms should convert such analog video waveforms to ITU-R BT601-4 Component (4:2:2) waveforms as soon as possible in the signal processing chain, with no processing node backwards conversions to analog waveforms allowed.

(VWG, 26 March 1997 - Approved for Study)

APPENDIX C

Note: This Section is a Work In Progress.

Appendix C provides information concerning very low data rate (sub T1) video dissemination systems. Note that there is a fair amount of chaos (from a standards perspective) in very low data rate video dissemination systems (such as QSIF Internet based video). Time is the only cure for such chaos and users must be flexible as this particular technology domain continually re-invents itself.

APPENDIX D References

ISO/IEC 13818-1, “Information technology - Generic coding of moving pictures and associated audio information, Part 1: Systems,” 1995 (also known as MPEG-2 Systems), including Amendment 1: “Registration Procedure for Copyright Identifier,” Amend. 2: “Registration of Private Data,” and Draft Amendment 3: “DSM-CC and Private Data.”

ISO/IEC 13818-2, “Information technology - Generic coding of moving pictures and associated audio information, Part 2: Video,” 1995 (also known as MPEG-2 Video), including Amendment 1: “Registration Procedure for Copyright Identifier,” Amendment 2: “4:2:2 Profile,” Amendment 3: “Multiview Profile,” and Draft Amendment 4: “ITU-T Extension Code Assignment.”

ISO/IEC 13818-6, “Information technology - Generic coding of moving pictures and associated audio information, Part 6: Extension for Digital Storage Media Command and Control,” 1996 (also known as MPEG-2 DSM-CC).

ISO/IEC 13818-9, “Information technology - Generic coding of moving pictures and associated audio information, Part 9: Real-Time Interface Specification,” 1996 (also known as MPEG-2 RTI).

ITU-R BT.601-4, Encoding parameters for digital television for studios, 1994.

ITU-R BT.1208, Video coding for digital terrestrial television broadcasting.

ETR 211 “Digital broadcasting systems for television, sound, and data services: Guidelines for the usage of Service Information (SI) in Digital Video Broadcasting (DVB) systems,” 1994.

ETR 162, “Digital broadcasting systems for television, sound, and data services: Allocation of Service Info. (SI) codes for Digital Broadcasting (DVB) systems,” 1995.

ETS 300 468, “Digital broadcasting systems for television, sound, and data services: Specification for Service Information (SI) in Digital Video Broadcasting (DVB) systems,”. 1994 (also known as DVB SI)

ETS 300 743, “Digital Video Broadcasting (DVB); DVB subtitling,” 1996.

EIA, *Recommended Practice for Advanced Television Closed Captioning* , R-4.3 subcommittee. draft, July 1, 1994.

EIA 608, Recommended Practice for Line 21 Data Service, September 1994.

SMPTE 259M, 10-Bit 4:2:2 Composite and 4 fsc Composite Digital Signals – Serial Digital Interface, 1995.